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DEVICE CONVERTING THERMAL ENERGY INTO KINETIC ONE BY USING SPONTANEOUS ISOTHERMAL GAS AGGREGATION

My invention is a device converting thermal energy into kinetic one,related to the group of machines using four-phase basic thermodynamic processes like Carnot or Otto cycles.These devices need,for their operation,some kind of available outside heat source to be converted into kinetic energy.They consist of continuously lubricated moving parts,working in high temperatures,with quality deteriorating by usage and with noise emission.

My invention uses rarefied gas in a novel three-phase thermodynamic cycle,as shown in Fig.1(p,v diagram), of which the first phase is a spontaneous isothermal gas aggregation (0----1), equivalent to an ideal isothermal compression, the second phase is an adiabatic expansion (1----2), with work produced via an expander and the third one is an isobaric expansion (2----0) where,by means of an exchanger,the cooled gas is reheated again (q_2) by cooling the ambient air.The shaded area below the adiabatic path (1----2) represents the work done at the expense of the internal thermal energy of the gas(Iso).The first phase arises when the gas passes through numerous special microscopic holes, with sizes comparable to the mean free path of the molecules,so that the latter do not collide with each other but only with the walls. I have thought up smart geometric shapes for these holes,like slot(Fig.2) and cone(Fig.3) with diverging inner surfaces,cavity(Fig.4) with segments of spherical inner surfaces, in order that the molecules may take advantage of a phenomenon (to be discussed further down the text),with the result that,during successive rebounds upon the inner walls,they tend to move forward,forming a small but discrete net flow from the input(i) to the output (o).The solid lines with the arrows show the central paths of the swarms of molecules.Under these special conditions the gas comes out of the holes spontaneously and isothermally,enterring a room with increased density.

Obviously, there result five advantages by the use of my invention, ie (1)

energy production at the expense of the internal thermal energy of the gas, which then is reheated by the ambient air, (2) refrigeration for any domestic appliances,(3) no moving parts (except the expander), (4) high quality operation and (5) no noise.

D e s c r i p t i o n.

Fig.5 (parallel view and cross section S-S) shows the device,consisting of a vacuum glassvessel (1) divided into two rooms (2) and (3) by a region (4) containig the microscopic holes' assembly and consisting of a great number of holes grouped into standard small modules (m),all arranged in a parallel layout as regards the gas flow.The closed circuit of the gas flow is supplemented with an adiabatic expander (5), within room (3), and a heat exchanger (6) in the return path of the gas from (3) to (2),transferring heat from the ambient air (7) to the gas with the help of ventilator (8). With suitable pressure difference between (2) and (3) an optimum flow is established,so that the device is continuously performing work, eg by means of a generator (9),coupled to the expander through a magnetic clutch (10) and a speed reduction gear (11) (if needed), and at the same time it offers cooling possibilities.

T h e P h e n o m e n o n.

The operation of the device is based on a phemomenon observed at the time of the experimental research and evaluation of the external friction of gases [1],where it was shown that the molecules in a rarefied gas,rebounded from the inner walls of the container,under suitable vacuum pressure,do not exactly obey the so called cosine-law (uniform rebound to all directions) [2,p.27],but,due to the existence of a molecular layer,adsorbed upon the walls,their path directions tend to slightly incline towards the perpendiculars to the walls, provided that the inner surfaces are quite smooth and the size of the container comparable with the mean free path of the molecules. Both of these properties are very important. The surface smoothness inside the holes must be perfect enough for the adsorption layer to cover the surface irregularities completely,otherwise the layer action is cancelled and the cosine-law prevails

again. Fortunately, nowadays a state-of-the-art value of surface roughness has been realized down to 1 nm,rms and even better [3],while in earlier decades values of less than 20 nm apparently had not been reached [4,p.622]. With regard to the size, I have taken the fundamental dimension of the holes $\ell =$ 10 μm,which size is relatively easily realizable,happily in accordance with the technological progress of these days on Micro-Electro-Mechanical-Systems (MEMS) [5,p.56] and which is conveniently adaptable to the selected mean free path $\lambda = 10\ \mu m$,as well as to the corresponding pressure [6,p.24],within the range of a well developed molecular layer. Finally,I consider worth mentioning that this peculiar behaviour of the molecular layers offers a natural explanation of the repulsive forces between adjacent corpuscles in the Brownien motion phenomenon and also in the expansion of dust in the air [1,p.331].

Industrial Applicability.

The device has not been realized and tested experimentally.Nevertheless,its successful working ability is indeed proved indirectly, because it is based on the experimental and theoretical work mentioned in [1] as well as on a simulation method,assisted by electronic computer programs,to be described quantitavely as follows.

The Simulation Method.

In order to evaluate the amount of flow through the microscopic holes,it is necessary first to calculate the number of molecules emitted from any point A of the inner walls and fallen on any other point B as a function of the geometric parameters (dimensions,angles) of the holes.

Following the computer symbolism,let

AB[m] = distance between two points A and B located anywhere on the inner walls of a hole.

na[sw/m^3] = swarm of molecules per unit volume(volume density) around A

dna[sw/(m^2*s)] = swarm of molecules per unit area per unit time rebounded from A within an infinitesimal stereo-angle dΩ[sr] towards B.

v[m/s] = arithmetic mean velocity of the molecules

cfa,cfb = cosines of angles φ_A,φ_B between AB and the perpendiculars on the respective infinitesimal facets dsa and dsb at A and B .

na*v/4[sw/(m^2*s)] = molecules per unit area per unit time (surface density) rebounded from A to the inner hemisphere.

Then,in the absence of the adsorbed layer the cosine-law is expressed as follows [2,p.27], (Pi means π):

dna = na*v/(4*Pi)*cfa*dΩ = na*v/4*cfa*cfb/(Pi*AB^2)*dsb

Or,in reduced form (divided by no*v/4 and multiplied by dsa/dsb)

dna*dsa/(no*v/4*dsb) = wa*cfa*cfb/(Pi*AB^2)*dsa (1)

where wa = (na*v/4)/(no*v/4) = relative surface density on A, wo=no*v/4 = input surface density. On integration of dΩ over the inner hemisphere we obtain the basic quantity na*v/4. The factor cfa expresses the cosine-law.

Now,in the presence of the adsorbed layer the cosine-law is to be modified, ie the factor cfa should be substituted by [1,p.325]

{[1-2/3*f(p)]*cfa+f(p)*cfa^2}, where f(p) is an increasing function with the pressure and with f(p)$_{max}$ = 3/2, occuring at p=1,918mmHg, which corresponds to (3/2*cfa^2) as a substitute of cfa. In that case

dna*dsa/(no*v/4*dsb) = wa*3/2*cfa^2*cfb/(Pi*AB^2)*dsa (2)

This formula may be used at least also for pressures above 1.918[mmHg], up to 23,2mmHg, which corresponds to the maximum thickness of the layer and beyond,given that it does not drop quickly after the maximum [1,p.305,Table]. The forms of the holes are selected to possess some kind of symmetry so that the inner walls,as reflecting surfaces,may be divided into a large number (n) of strips (for the slots) and rings (for the cones and cavities),as shown in (12) of Figs 2,3,4. The same thing may be done on the input (i) and output (o) surfaces.Then,the relative density wa is constant along a strip or a ring. I have to remark that wa,when referred to the walls is an unknown,while when referred to the input surface it is known and equal to 1,and when referred to the output surface it is equal to the compression factor k between input and output.So,for each point B we are allowed to integrate (sum up) equations (1)

and (2) over each strip or ring,having previously expressed these equations as functions of the geometric parameters of the holes.After integration (addition) and by putting i for $A_{i(=1,2,3,...n)}$ and j for $B_{j(=1,2,3,...n)}$, I rewrite equations (1) and (2) in a new form

$sw_{ij} = w_i*fbbp_{ij}$ (layer absent) |

$sw_{ijij} = w_i*fbbp_{ij}$ (layer present) | (3)

where sw_{ij} = swarm of molecules per strip or ring per unit time,rebounded from the strip or ring containing A_i to B_j,per unit area for B.

$fbbp_{ij}$ = transmission coefficients from a strip or ring i to point j, that are calculated as functions of the geometric parameters. In order to find the n unknown densities, I express,in the form of equation,the following equality which,under steady-state conditions,takes place between the number of molecules fallen on any reflecting point j and the number w_j rebounded from the same point.

$\Sigma_{i(=1,2,3,...n)} sw_{ij}$[reflecting surface]+$\Sigma_{i(=1,2,3,...n)} sw_{ij}$[input surface]
+ $k*\Sigma_{i(=1,2,3,...n)} sw_{ij}$[output surface] = w_j (4)

The first sum includes the unknown variables w_i. The second and third sums are known. In terms of equations (3) this equality, appropriately rearranged, becomes an n-variable linear equation for point j:

$$\Sigma_{i(=1,2,3,...j-1)} fbbp_{ij}*w_i + (fbbp_{jj}-1)*w_j + \Sigma_{i(=j+1,j+2,...n)} fbbp_{ij}*w_i = - \Sigma_{i(=1,2,3,...n)} fbbp_{ij}(input) - k*\Sigma_{i(=1,2,3,...n)} fbbp_{ij}(output) \quad (5)$$

Finally,we have a system of n n-variable linear equations,which may be solved with the help of Gauss algorithm [7,p.44-28].

Three Examples.

Having established the numerical values of the n variables (densities),both for layer absence and layer presence conditions,it is easy to calculate the algebraic ~~sum~~ Fl(k) of flows of molecules through the input or output (it is the same), including all the path combinations.This net overall flow Fl(k) is a linear function of ~~k~~,reduced to the unit of input surface density no*v/4 and to the unit of area l_o^2 (slots and cones)[Figs 2,3] and r^2 (cavities)[Fig.4], ($l_o = 2*\ell$, $r = \ell$).

Under layer absence and for k = 1 we have Fl(1) = 0,which complies with the cosine-law.Under layer presence and for k = 1 we have Fl(1) =Flm(maximum) and for k = km(maximum) the flow stops,ie Fl(km) = 0. Under layer presence :

Fl(k) = Flm*(km-k)/(km-1) (6)

Flm and km are also functions of the geometric parameters of the holes,ie li,ω for slots and cones (Figs 2,3) and ac0,bd0 for cavities (Fig.4).Optimum values:

Geometric parameters	slot	cone	cavity
li(=li/lo)	0,4	0,5	
ω[rad]	1,4	0,8	
ac0=bd0[rad]			0,7227
Overall flow Flm	0,052	0,0218	0,1600
Compression factor km	1,1100	1,2500	1,2000

km is found by the trial-and-error method or directly with the formula:

km = (A-Flm)/A (A=program under layer presence,k=1, zero input) (7).

Because of the great number of holes needed to achieve a somewhat remarkable result,I have organized the construction of the device in a form of small modules,as shown in Fig.6,consisting of a certain number (s) of parallel very thin panels,say xe(=0,3cm)*ye(=2,1cm),each perforated with a number of holes ((13) for parallel slots of length all the way of the module's y-dimension, (14) for cones and cavities) and arranged in a pile(15) of height

H(s) = s*h+2*d (8)

where h(=0,2cm) = distance between successive panels, d(=1cm) = input or output air ducts. The arrows show the path of the molecules.Suitable supporting rods ((16),solid lines) fix the panels in place.Along z we have (s) holes in series and the molecule compression factor is k^s (=k_1*k_2*...*k_s),(k_1=k_2=...=k_s=k).

The number Nmod(=ax*ay) of holes per panel or of piles of holes per module is estimated to

	Slot	Cone	Cavity	
Nmod = ax*ay =	80*(2cm/lo)	100*400	66*400	(9)

Two gases,Helium and Hydrogen,have been chosen as the most suitable for use with ~~the~~ device.The present examples will work with Hydrogen (mass g[kg] = 0,3347/10^{26} , arithmetic mean velocity v[m/s] = 1693 [6,p.323]).

Now,Fig.7(not in scale) shows a possible arrangement (18) of these modules (m) within a part O = 0,04241 m^3 (W=0,054 m) of a space (17) with dimensions X = 1m and D(diameter) = 1m, which will contain the device of Fig.5(modules'assembly and expander). I have taken a limited value of O in order to accommodate a heat exchanger of reasonable size for the device. The arrows indicate the gas flow directions(i=input, o=output). Then,the number v(s) of modules contained in O and the whole number Np(s) of piles of holes is,

$$v(s) = O/(xe*ye*H(s)) \quad \text{and} \quad Np(s) = Nmod*v(s) \qquad (10)$$

With regard to Fig.1:Work done per cycle(shaded area) [8,p.244]

$$ls[J/kg] = R[J/(kg*K)]*To[K]/ (n-1)*\{1-(1/k^s)^{((n-1)/n)}\} \qquad (11)$$

R[4,p.872] = 4124, n[4,p.872] = 1,409

To[K] = 253 for slots, 273 for cones and cavities (see next paragraph).

In order to maximize the output power, the following expression a(k), which is a product of three factors in Eqs (6),(8),(11),contained in the power output formula, must be maximized with respect to(k) and with (s) as a parameter,given that (s) may not exceed a limit (so),where the mean free path still remains "free" within the last holes,

$$a(k)=(km-k)/(km-1)/(s*h+2*d)*\{1-(1/k^s)^{((n-1)/n)}\} \qquad (12),$$

to find k=ko,s=so.Computed values of ko, so, Fl(ko),H(so), v(so), Np(so), lso follow:

	slot	cone	cavity
ko	1,05225	1,106	1,085
so	17	9	11
Fl(ko)	0,0273	0,01256	0,0920
H(so) [cm]	5,4	3,8	4,2
v(so)	12465	17715	16028
Np(so)/10^6	997,2	708,6	423,1
lso [J/kg]	566933	637950	630466

With plenty of margin (h) between successive panels and ample input-output air ducts (d), the speed of flow outside the holes is kept within a few meters per second,practically eliminating friction losses and noise.

Expander and Heat Exchanger.

The expander [9,p.449] is a single-stage reaction gas turbine, accommodated within the device(Fig.5,(5)).Its main features of interest here are the wheel diameter (D),the revolving speed (n) and the efficiency factor $\beta exp=0,825$[9,p.271].

The exchanger[4,p.470-472] is constituted of 30 glasstubes (Fig.5,(6)) in parallel, 0,05m in diameter,1m of length,situated along and around the device.The gas H_2 passes(in laminar flow) through the tubes,while air (Fig.5,(7)) is forced (in turbulent flow) around them, in the opposite direction,as shown by the arrows, by means of the ventilator (Fig.5,(8)),.with velocities 2 to 5 m/s.

In order to realize such a reasonable size of this component, it was necessary to let a greater temperature drop between warm air and cool H_2(40°C for slots, 20°C for cones and cavities). Fig.8 shows schematically [9,p.271] the heat exchanger and the corresponding flow diagram.The horizontal and slanted arrows show air- and H_2-flow,vertical arrows show heat-flow. The (conputed) pressure drop, in the H_2-flow is too small to be taken into consideration.

Calculated values of (D), (n), and the working pressures and temperatures are as follows (c_v[kcal/(kg*K)] = 2,41[4,p.871], e[kcal/J] = $0,2388/10^3$):

	Slot	Cone	Cavity
EXPANDER D[m]-n[rev/min]	0,60-3630	0,41-3630	0,44-3630
Pressure input p_1=po*ko^so	1020*2,377	1121*2,48	1121*2,45
output po [Pa]	1020	1121	1121
Temperature input To(=Td)	253	273	273
Output Tc=To-βexp*lso*e/c_v	206,7	220,8	221,5
EXCHANGER Input air tempTa	293	293	293
Output air temp. Tb	246,7(-26,3°C)	240,8(-32,2°C)	241,5(-31,5°C)
Input H_2 temp. Tc	206,7	220,8	221,5
Output H_2 temp. Td(=To)	253	273	273
Ta-Tb =Td-Tc	46,3	52,2	51,5
Air flow rate[m^3/s]	0,95	0,66	0,77
Ventilator Power Ivent.[w]	190	120	140

Hydrogen re-heating thermal energy (Fig.1) [8,p.235]: $q_2 = c_p*(To-Tc)$

(c_p[kcal/(kg*K)] = 3,40 [4,p.871]	Slot	Cone	Cavity
q_2[kcal/kg]	157,42	177,48	175.10

Numerical Results.

Finally, I proceed to calculate all the factors which determine the output power: Loschmidt number[6,p.17] ($p=1{,}02*10^5$ Pa, T=273K) =

= $2{,}687*10^{25}$ molecules/m^3		Slot	Cone	Cavity
Input pressure	po[Pa]	1020	1121	1121
	po[mmHg]	7,68	8,41	8,41
Input Temperatue	To[K]	253	273	273
Input Vol.Density	no[sw/m^3]/10^{23}	2,900	2,950	2,950
Hydrogen Velocity	v[m/s]	1630	1693	1693
Input Surf.Density :				
wo = (no*v/4)[sw/(m^2*s]/10^{23}		1182	1249	1249

lo[m] = $20/10^6$ r[m] = $10/10^6$

Mass flow rate per hole: Slots and Cones gf[kg/s] = $g*Fl(ko)*wo*lo^2$

Cavities gf[kg/s] = $g*Fl(ko)*wo*r^2$

Total flow rate G[kg/s] = gf*Np(so)

Power output of expander Iexp[watt] = βexp*Iso*G:

Power output(pract.) Ipr[watt] = Iexp – Ivent

	Slots	Cones	Cavities
Fl(ko)	0,0273	0,01256	0,0920
gf[kg/s]*10^{12}	4,32	2,10	3,85
G[kg/s]*10^3	4,308	1,487	1,629
Iso[J/kg]	566933	637950	630466
Iexp[watt]	2015	783	849
Ivent[watt]	190	120	140
Ipract[watt]	1825	663	709

Construction Hints.

Mass production can be achieved by the method of pressing [10,p.8-1], not excluding any other competent method. As construction material I would

propose glass,ceramic,silicon or the like, used in semiconductor technology. Fig.9 shows a slot panel ie an arrangement of parallel triangular rods (19), forming slots (s) in between,lying on supporting rods (20) (cross-section T_1-T_1) at suitable intervals.Cross-section T_2-T_2 of rods (1)..The distance between successive panels is h=0,2cm.Both forms of rods can easily be manufactured in mass production with the active surface (b) made very smooth by advanced polishing processes [5,p.56].

The slot solution presents evident advantages over the other two solutions in (a) manufacture (b) greater output power per unit volume.

Fig.10 shows a cone panel (21) with cones (c) (cross-section T_2-T_2),arranged in series along x,lying on supporting rods (22) (cross-section T_1-T_1),wich are placed between adjacent cone series.Intervals between successive panels are equal to h=0,2cm.The cone active surface (b) is made very smooth.Fig.11 shows a possible scheme for cone panel fabrication,with the help of molds (2a,cylinders),(2b) and (p) as pressing means.

Finally,Fig.12 shows a cavity panel (23),carrying the holes with the active spherical surfaces (b) and the supporting rods (24) (cross-sections (T_1–T_1,T_2– T_2)), carrying the active spherical surfaces (c).At suitable intervals along the rods(24), a contact rod (25) is made in place of the corresponding active surface (c),with elimination of the opposite side hole,in order that the panel is rigidly supported.Figs 13 and 14 show the forming of the active surfaces (b) and (c) of the cavity respectively,with the help of molds (3a),(3b),(3c,cylinders),(p) for Fig.13 and (4a),(4b),(p) for Fig.14. To achieve the exact spherical surface the molds should be equipped with tiny balls s (dia. 20μm),with smooth spherical shape,like those used in miniature ball-bearings [11].

Computer Programs.

A 3 $^1/_2$ in. floppy disc is available,containing the programs (written in Q-basic) of the present invension.

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CLAIMS .

1. Device converting thermal energy into kinetic one, related to the group of machines using four-phase basic thermodynamic cycles and converting thermal energy into kinetic one by means of an available outside heat source, c h a r a c t e r i z e d by the fact that it uses rarefied gas in a novel three-phase cycle, of which the first phase is a spontaneous isothermal gas aggregation (0----1)),equivalent to ideal isothermal compression, the second phase is an adiabatic expansion(1---2), producing work, via a gas turbine (5), at the expense of the internal thermal energy of the gas and the third phase is an isobaric expansion (2----0), where the expanded gas is re-heated, via a heat exchanger (6), while cooling the ambient air (7). Phase (0----1) is accomplished when the gas passes through numerous special microscopic holes (4) with sizes comparable to the mean free path of the molecules and with smart geometric shapes,ie slot(26) and cone(27) with diverging inner surfaces,cavity(28) with segments of concave spherical surfaces, or the like,grouped together in small parallel modules, allowing the gas to take advantage of a peculiar property of the molecular layer adsorbed upon the inner walls of the holes,which layer slightly diverts the (normally) uniform rebound of the molecules towards directions more close to the perpendiculars to the inner surfaces, with the net result that a small but discrete amount of gas is passing through the holes spontaneously, achieving an aggregated output.

AMENDED CLAIMS

received by the International Bureau on 15 September 2005 (15.09.05): original claims 1 have been replaced by amended claims 1-2 (1 page).

1. Device converting thermal energy into kinetic one,related to the group of machines using four-phase basic thermodynamic cycles and converting thermal energy into kinetic one by means of an available outside heat source, c h a r a c t e r i z e d by the fact that it uses rarefied gas in a novel three-phase cycle (Fig.1),of which the first phase is a spontaneous isothermal gas aggregation (0----1), equivalent to ideal isothermal compression, the second phase is an adiabatic expansion (1----2),producing work (eg via a gas turbine (5)) at the expense of the internal thermal energy of the gas and the third one is an isobaric expansion (2----0),where the expanding gas is reheated (eg via a heat exchanger (6)),while cooling the ambient air (7).

Phase (0----1) is accomplished when the gas passes through numerous special slots (26) of microscopic cross sections comparable to the mean free path of the molecules, with diverging flat surfaces and of considerable length (19), grouped together in small parallel modules.(13).The slots allow the gas to take advantage of a peculiar property of the molecular layer adsorbed upon the inner walls of the slots,which layer slightly diverts the (normally) uniform rebound of the molecules towards directions more close to the perpendiculars to the inner surfaces, with the net result that a small but discrete amount of gas is passing through the slots in the deverging direction sponaneously, achieving an aggregated output.(higher pressure).

2. Device as set forth in claim 1, in which the pressure of the gas,during phase (0----1), is maintained in the range favouring the formation of a maximum adsorption layer and also the temperature,during the isobaric expansion(2----0), is kept below the ambient one,in order that said device may use the ambient air as the outside heat source.. .

STATEMENT UNDER ARTICLE 19(1).

Having received and read the written opinion of the International Searching Authority and in order to ameliorate the situation of my invention, I propose herewith the following amendments under article 19(1),described on the accompanying sheet 'AMENDED CLAIMS'.

'Claim 1 as filed is replaced by the amended claim 1. New claim 2 is added.'

With regard to the amended claim 1,the reasons for the changes are the following: I admit that, among the three examples (slot,cone,cavity,Figs2,3,4 respectively) contained in the description of my invention,the examples on cones and cavities are physically similar to the pores as described in ref.D1,Figs 3 & 4,(12) of the written opinion. So consequently I decided to withdraw them in order to diminish the relevance of citations mentioned therein, and retain just the example using modules (Fig.6,(13)) based on slots (Fig.2,(26)).

In my opinion, a slot is physically not the same in comparison with a pore on a membrane, ref.D1,Figs.3 & 4,(12), because in my case the slot is conceived as having a microscopic cross section <u>but a considerable length</u>. In fact,if one looks at the construction hints (p.9 of the description), the slots (Fig.9) are composed of parallel rods with microscopic triangular sections (Fig.9,(19)) and with surfaces perfectly flat (planarized) in order that the adsorbed layer may work effectively.

Said surfaces are the simplest ones,they can easily be made with the help of MEMS technology and they are the best ones,as shown by my detailed computations.

Moreover, the flow of molecules within the membrane's pores is characterized by a random motion ie erratic Brownian movement (ref.D1,col.2,lines 18,19), while the situation within a slot of my invention is quite defferent and has nothing to do with Brownian motion (see my description or amended claim 1).

As to the added claim 2, I remark that, by my invention the temperature of the gas,during the isobaric expansion, must be kept below the ambient one, in order that ambient air (Fig.5,(7)) may be used for the heat exchanger (Fig.5,(6)).

In this way,we have contnuously energy production and at the same time refrigeration, without needing any external heat source.The device is actually a 'perpetual motion machine of the second kind',an as yet unsolved problem of thermodynamics (see [8],p.64 of my references).

Concerning par.3 of the written opinion, I believe that I have given adequate information in the description (construction hints,modules Fig.6(13),and rod assemblies constituting the special slots Fig.9(19),(20),so that a skilled person can easily produce the device (certainly with ~~the~~ help of MEMS technology).

Thus,I hope to have disclosed the device in a manner more close to the provision of article 5 PCT.

On this occasion, I would like to point out that my invention is based on a fundamental (theoretical and experimental) work carried out on the external friction of gases by W.Gaede (ref.[1] of my description) and consequently I consider my work as absolutely consolidated.

Finally, I think there is no impact that the above amendments might have on the description and the drawings of my invention.

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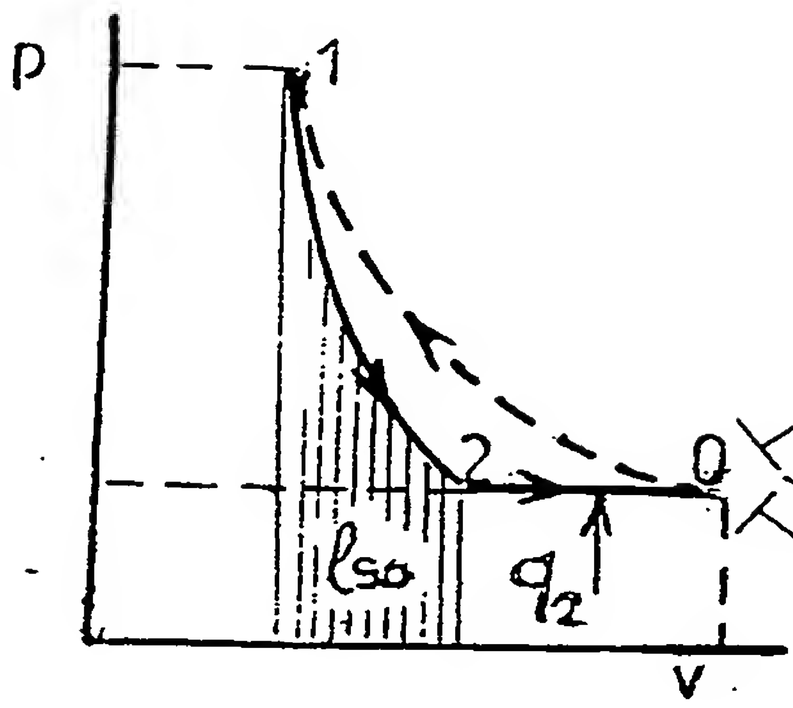

Fig.1

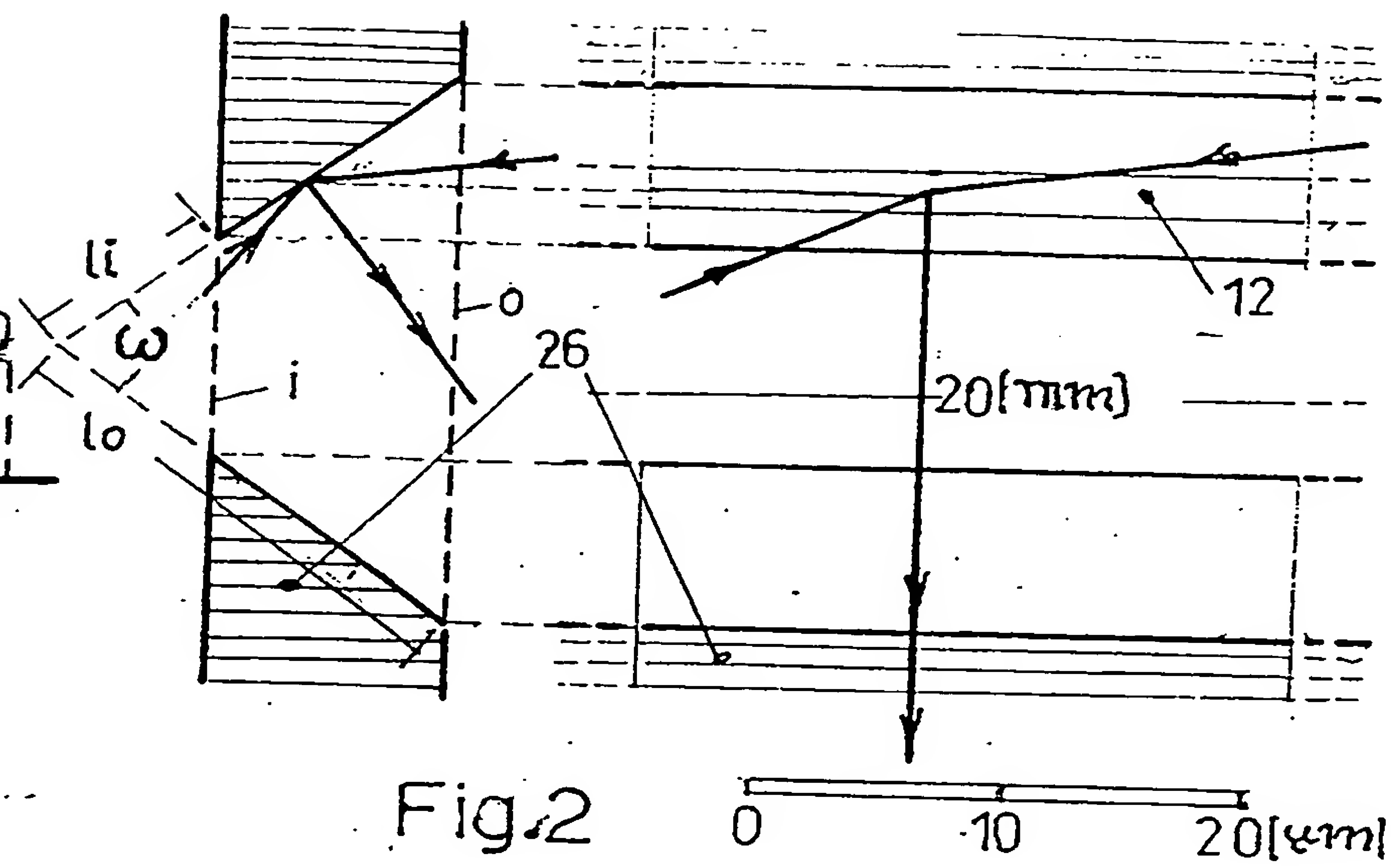

Fig.2

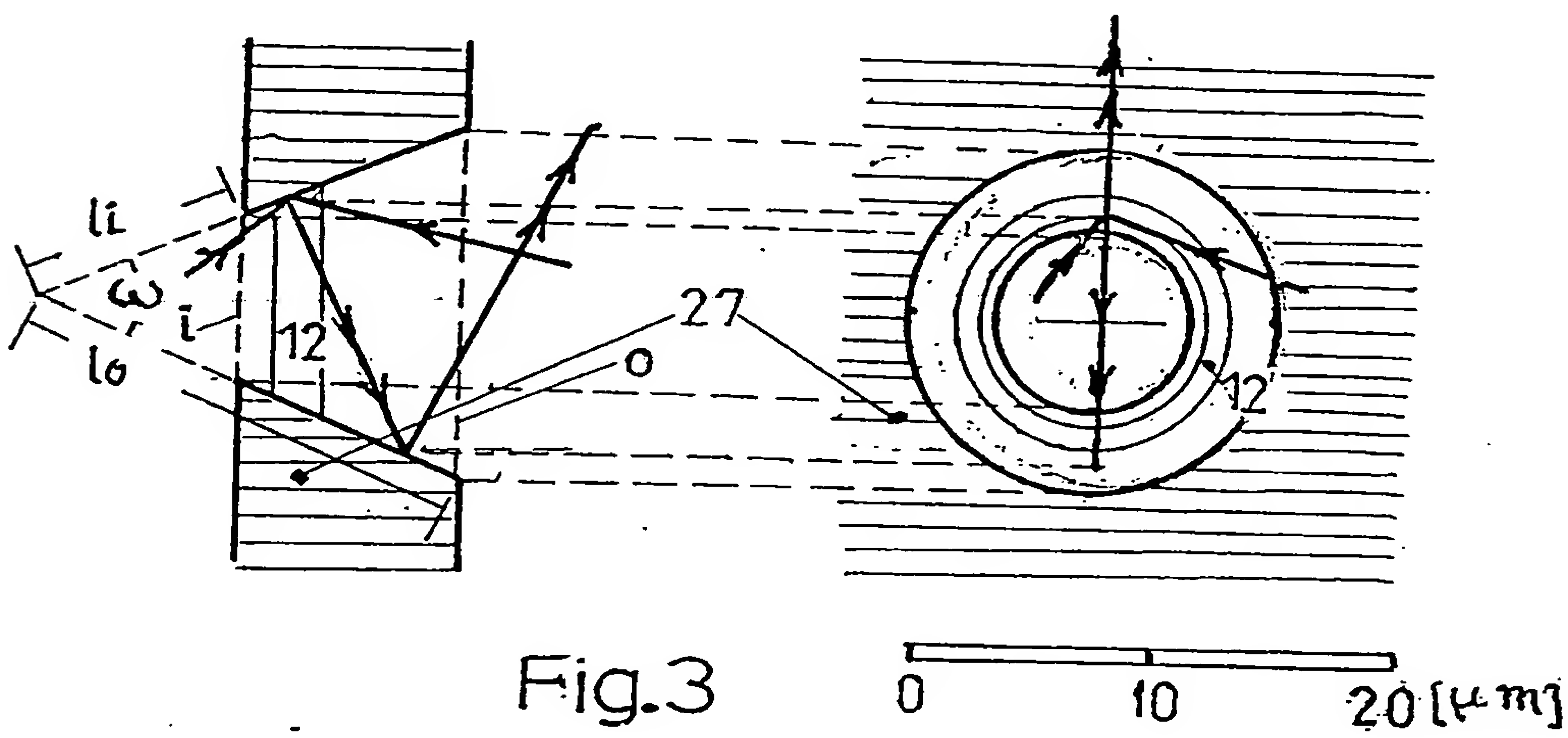

Fig.3

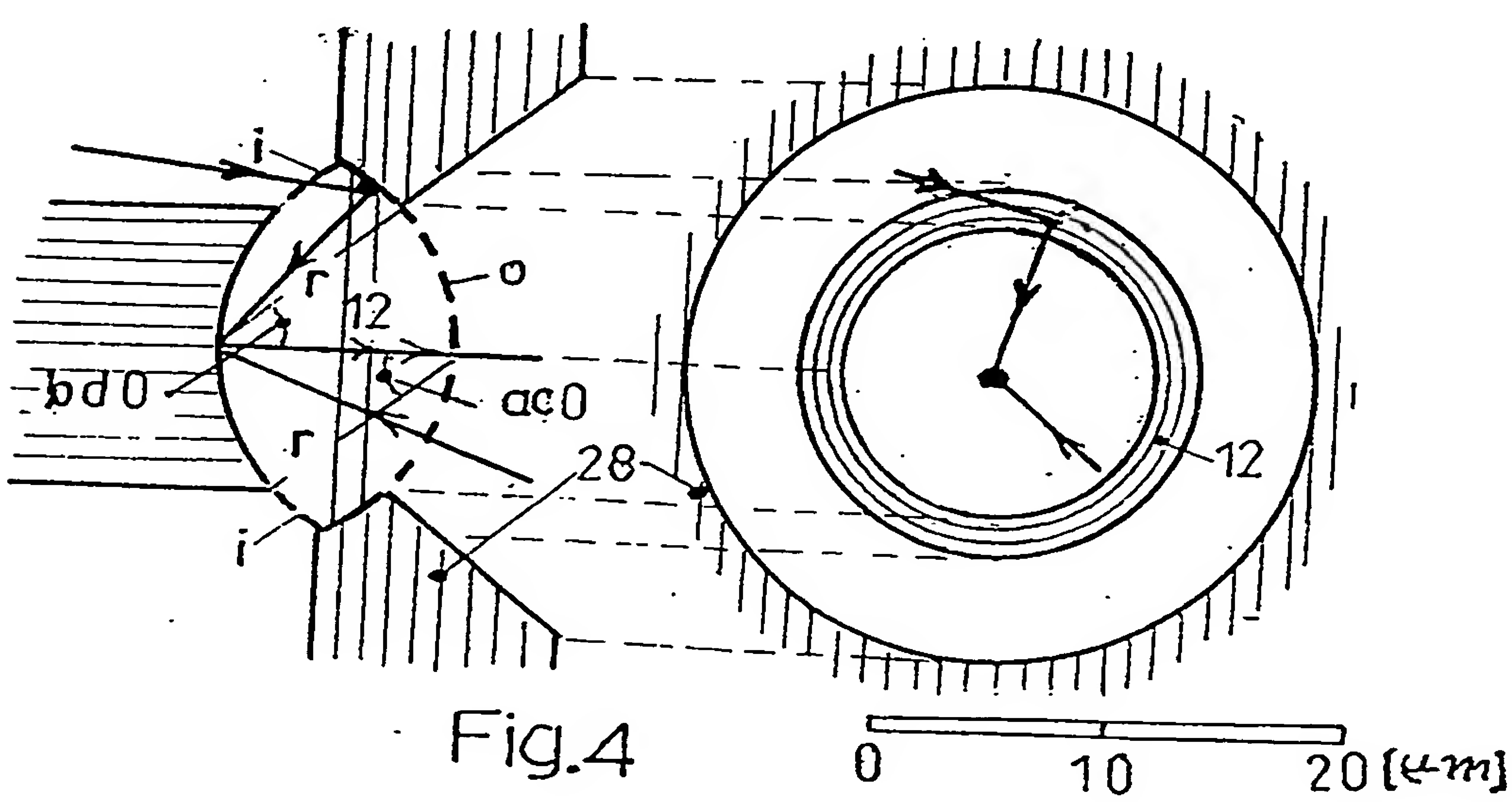

Fig.4

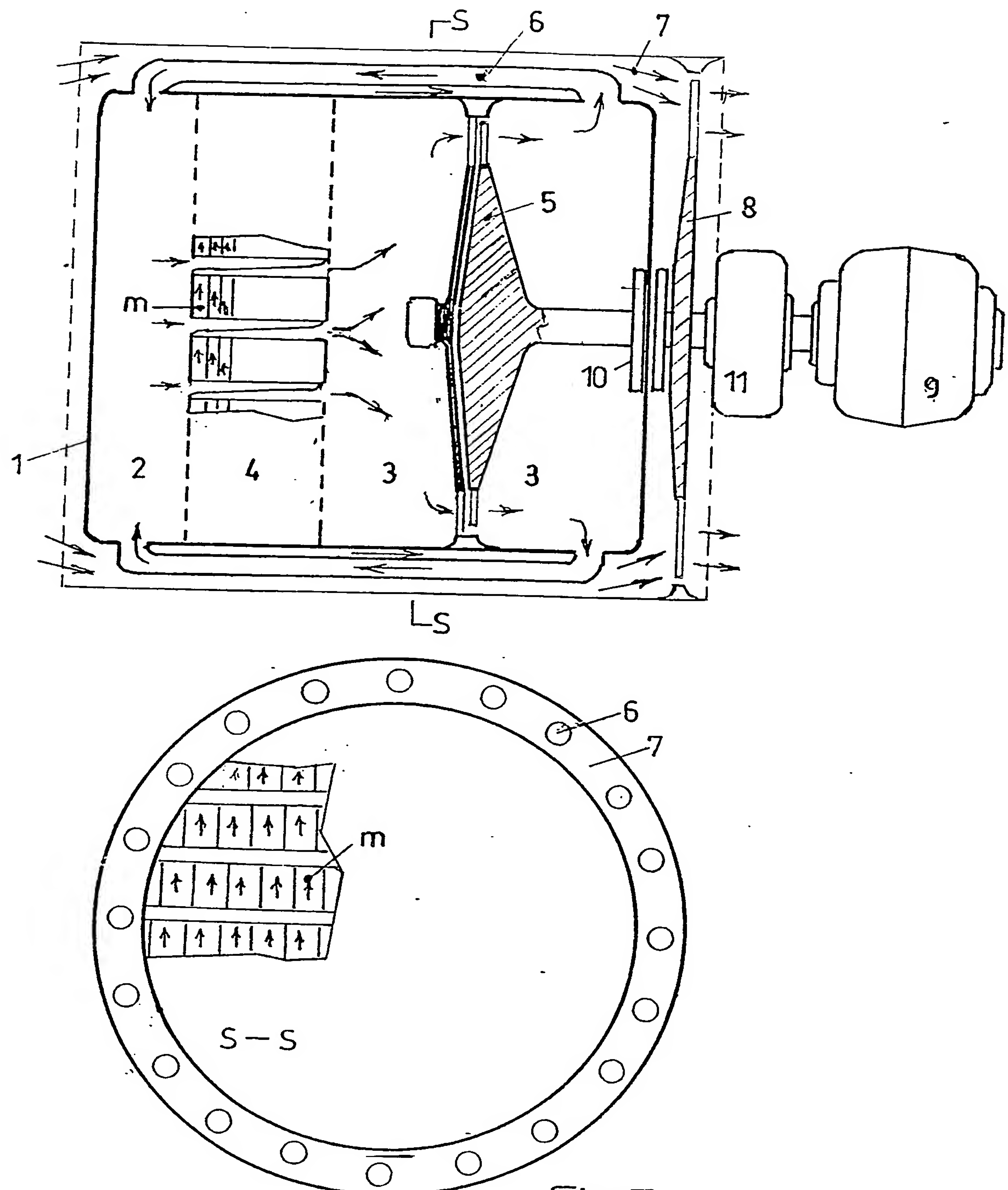

Fig.5

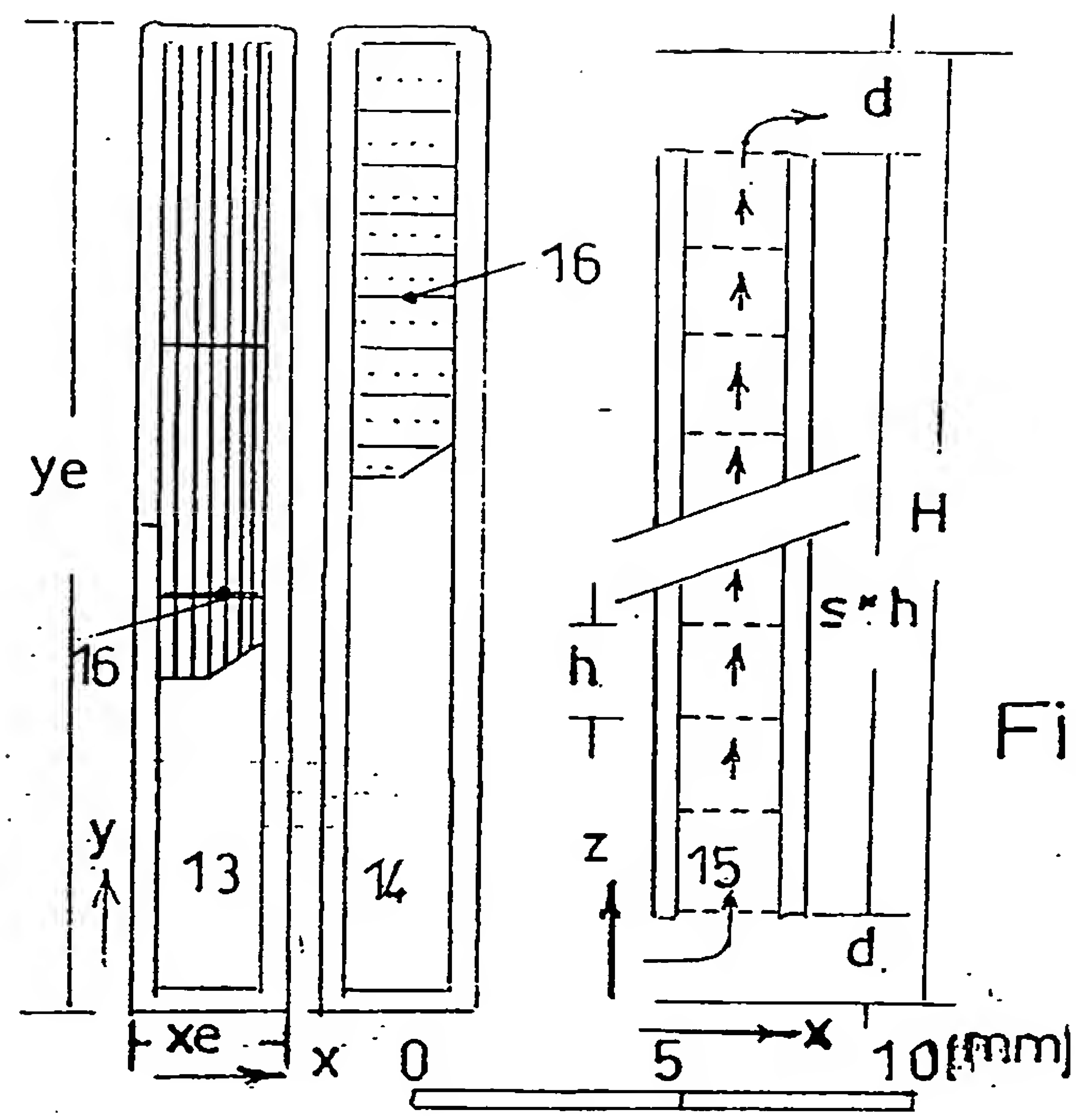

Fig.6

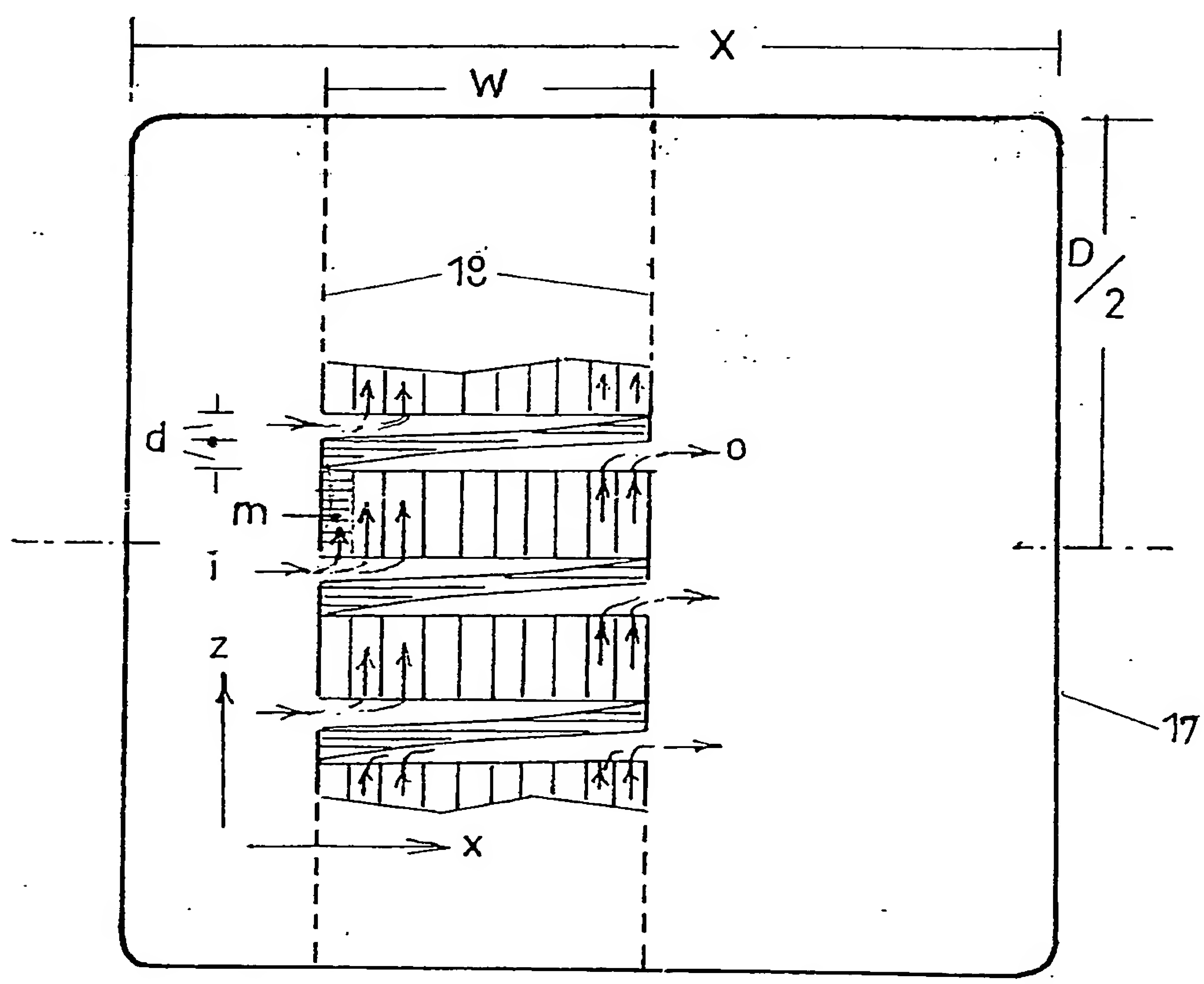

Fig.7

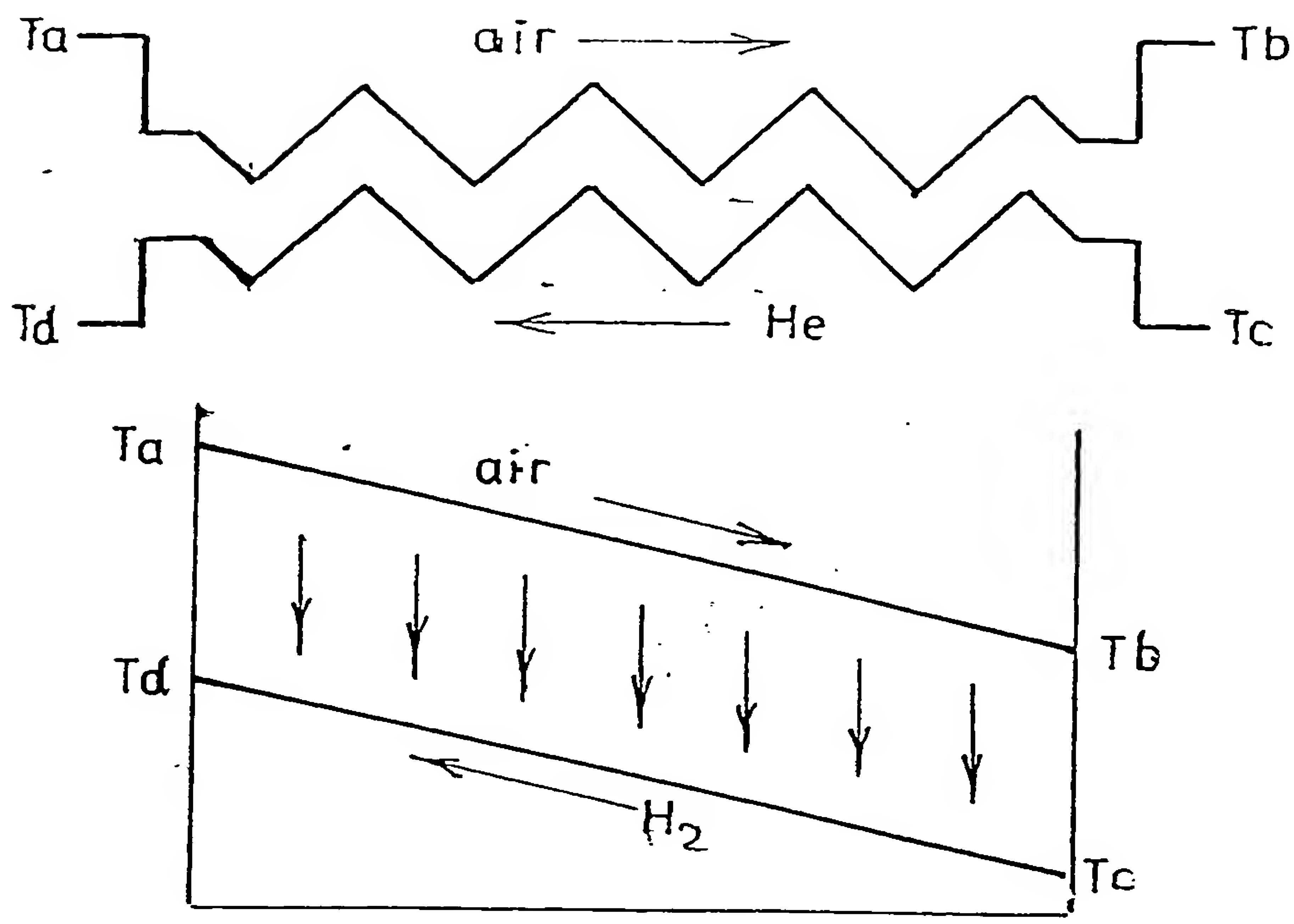

Fig.8

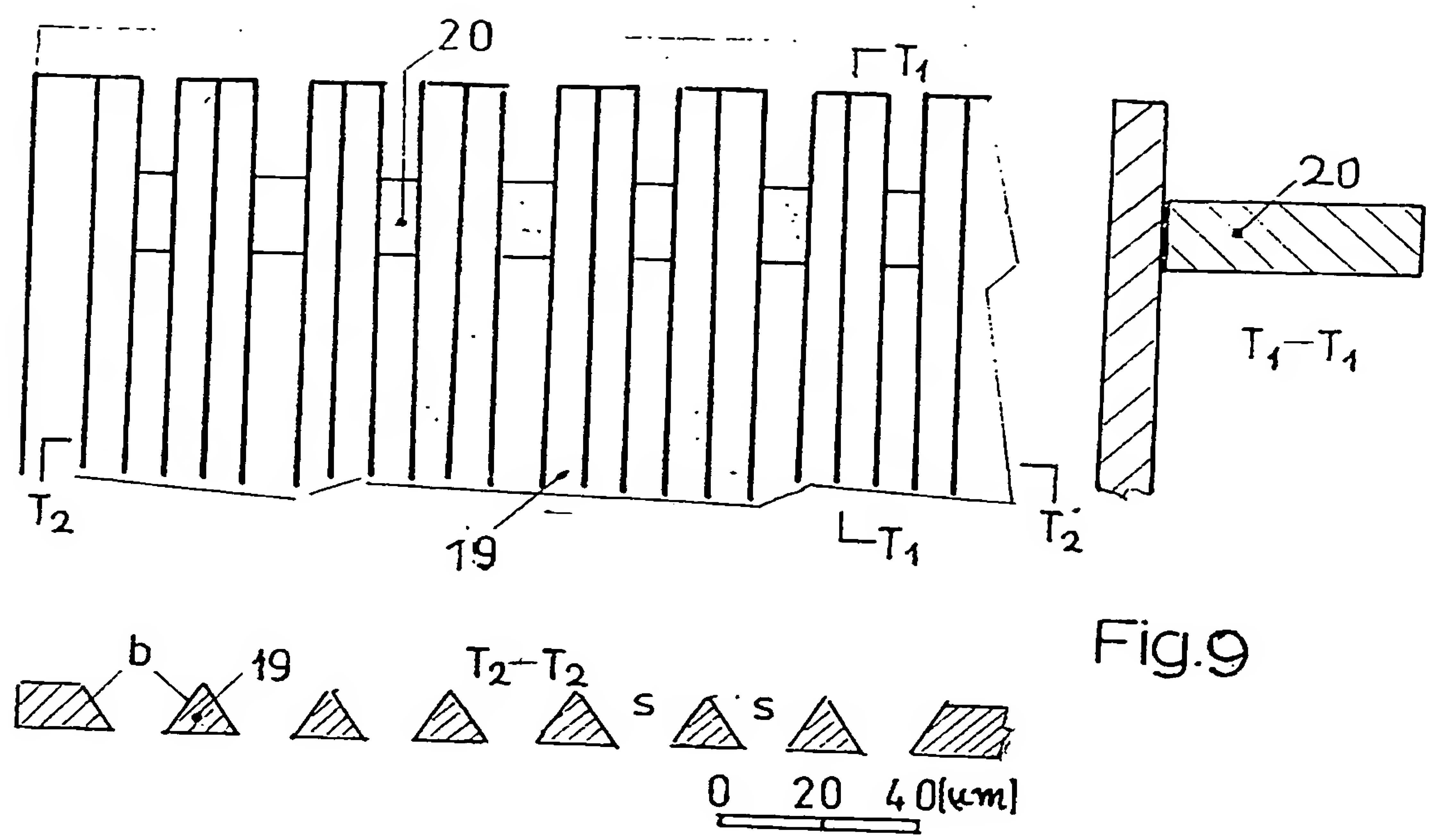
20
T1
20
T1–T1
T2
19
T1
T2
b
19
T2–T2
s
s
0 20 40[μm]

Fig.9

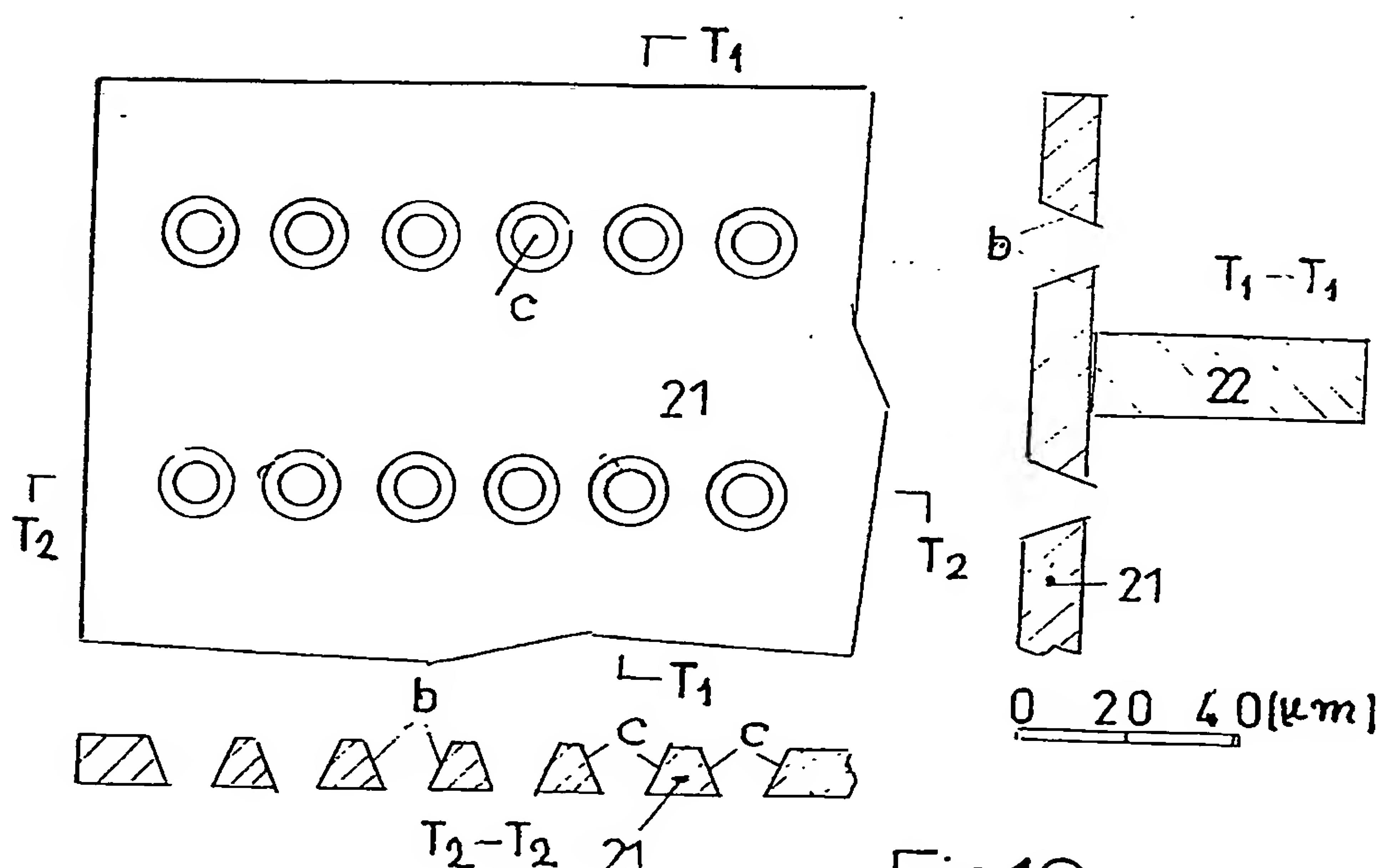
T1
b
T1–T1
c
21
22
T2
T2
21
T1
b
0 20 40[μm]
c
c
T2–T2
21

Fig.10

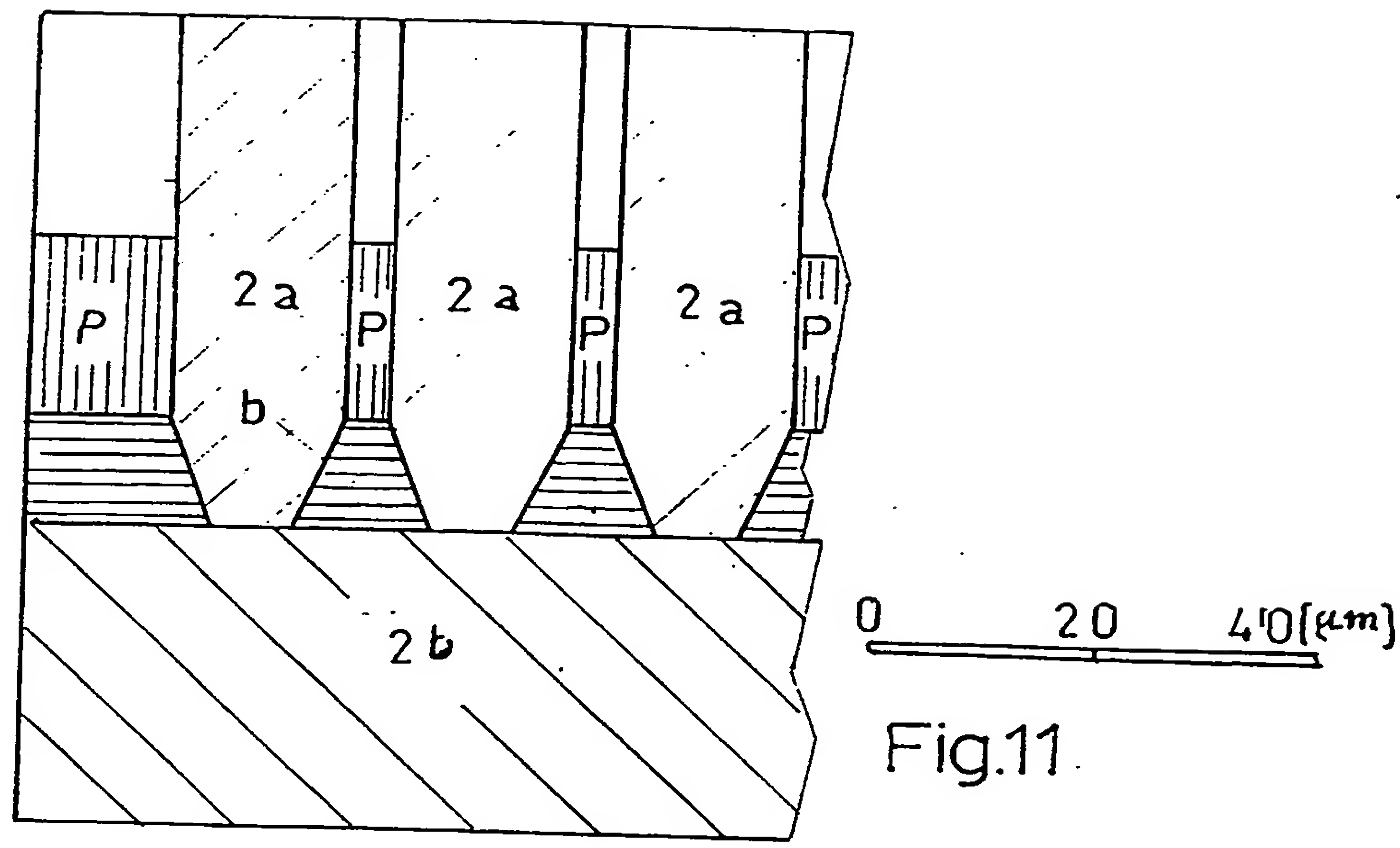
P
2 a
P
2 a
P
2 a
P
b
2 b
0 20 40 [μm]

Fig.11

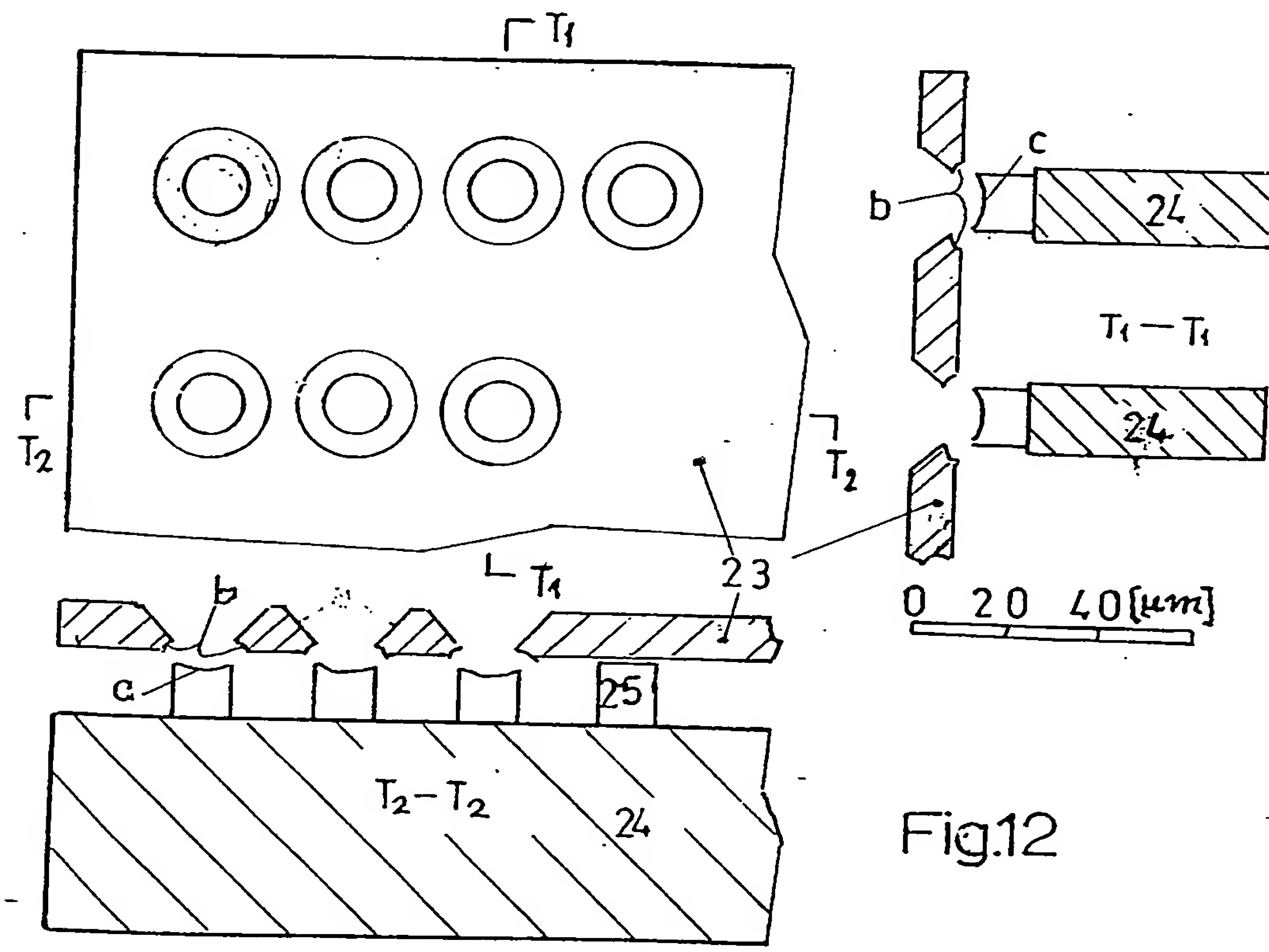
T1
T2
T2
T1
c
b
24
T1 — T1
24
23
0 20 40 [μm]
b
c
25
T2 — T2
24

Fig.12

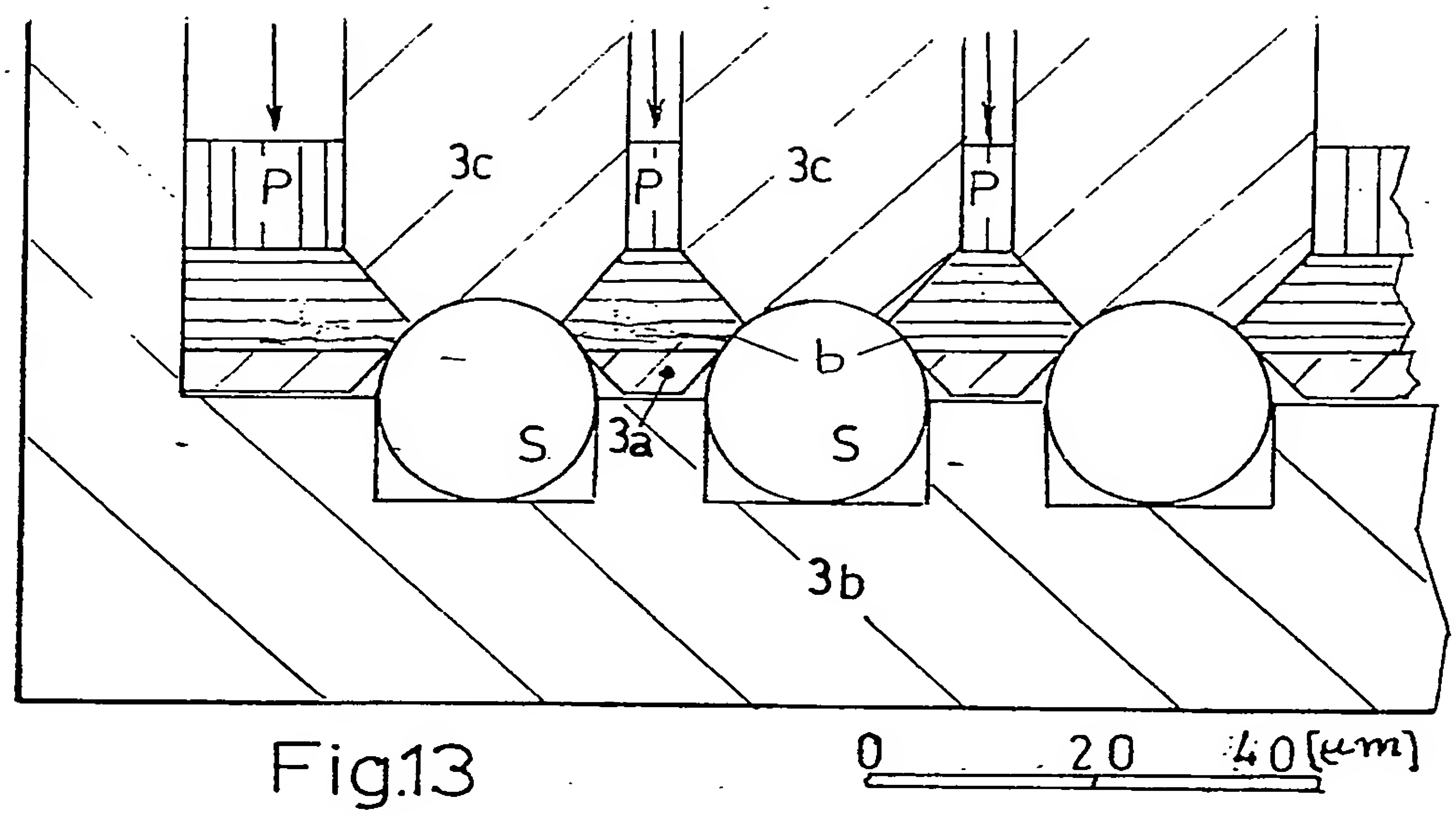

Fig.13

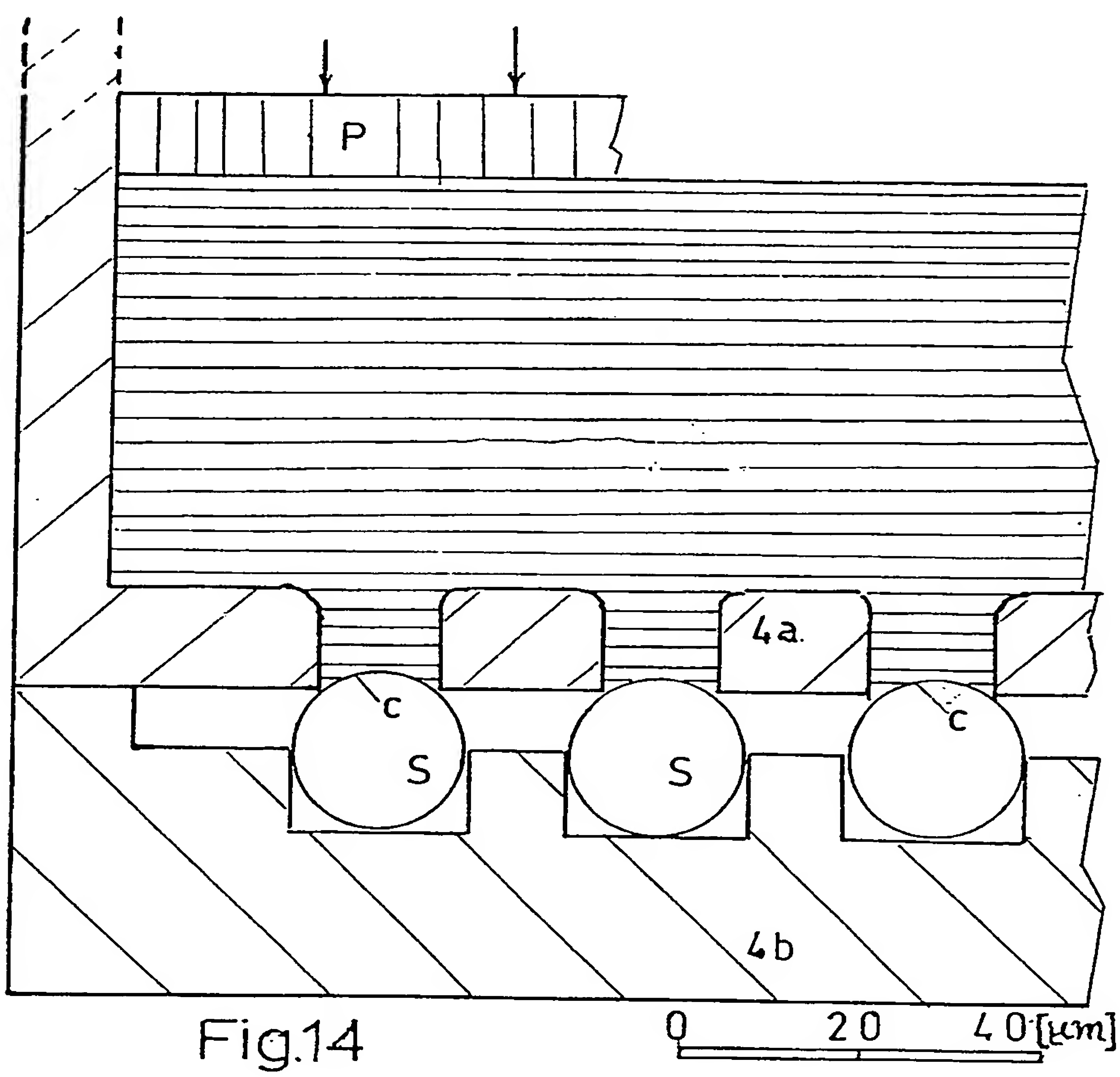

Fig.14

INTERNATIONAL SEARCH REPORT

Inte[redacted]nal Application No
PCT/GR2005/000010

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F02C1/10 F03G7/10 B81B1/00 F03G7/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F02C F03G B81B G21K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 316 568 A (BROWN ET AL) 31 May 1994 (1994-05-31) column 2, line 15 - line 45 column 4, line 4 - column 6, line 45 column 9, line 59 - column 11, line 2 column 13, line 46 - column 14, line 29 abstract; figures 1-4,18-21 -----	1
X	US 2003/145593 A1 (GOLDENBLUM HAIM) 7 August 2003 (2003-08-07) paragraph ‘0064! - paragraph ‘0076! paragraph ‘0087! - paragraph ‘0092! paragraph ‘0100! paragraph ‘0104! - paragraph ‘0110! paragraph ‘0267! - paragraph ‘0276! abstract; figures 6a-6e ----- -/--	1

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search

20 July 2005

Date of mailing of the international search report

28/07/2005

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INTERNATIONAL SEARCH REPORT

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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A	FR 2 533 622 A (GABRIELLI MICHEL) 30 March 1984 (1984-03-30) page 3, line 14 - page 5, line 11 abstract; figures	1
A	WO 94/20741 A (KIM, JAE, HWAN) 15 September 1994 (1994-09-15) page 9, line 4 - page 15, line 11 page 28, line 1 - page 30, line 1 abstract; figures 1-7,32,40-77	1

2

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INTERNATIONAL SEARCH REPORT

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Inte[redacted]nal Application No
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			AU	4030497	A	14-04-1998
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			WO	9420741	A1	15-09-1994

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